VISA GPIB software for interfacing the Tektronix 7854 oscilloscope

Installation and user manual

Nenad Filipović, M.Sc. EE

Abstract

With the aid of this program and a cheap USB-GPIB VISA compatible adapter, you can communicate with the Tektronix 7854 using a modern Windows based computer. 7854 features at a glance:

- 10bit waveform digitizer with averaging and many other mathematical functions
- IEEE-488 (GPIB) port able to transfer both measurement data and instrument commands
- Ability to execute CPU programs written in the 7854 proprietary programming language

However, IEEE-488 has gone a long way since 1980 when the 7854 was designed. 7854 remains electrically fully compatible with the IEEE-488, but responds only to its proprietary set of commands. For this reason, any software interfacing the 7854 over GPIB must employ a dedicated device driver.

National Instruments (NI) LabVIEW has a large database of instrument drivers including Tek 7854, but this NI driver comes with considerable limitations:

- Restricts usage only to NI hardware which is not usually affordable to enthusiasts/amateurs
- Driver functionality is severely limited compared to the 7854 instrument capabilities

Years after 7854 made an everlasting mark in digital oscilloscope development, VISA standard came into existence. It serves as an abstraction API layer between T&M instruments and their programming, helping to standardize instrument interface and widen the connectivity options. Instruments with VISA drivers are accessible using a wide variety of programs and connection hardware.

This document describes a Windows PC program written in NI LabVIEW which includes a dedicated VISA driver specifically written for the 7854. On top of this driver is a feature rich set of GUI controls to interface and use the 7854 oscilloscope from the PC. The advantage of VISA approach is the ability to use any VISA compatible GPIB adapter to connect the instrument to the PC, not only the NI adapters. With the advent of affordable USB GPIB adapters, enthusiasts and amateurs can now build labs at home. The amazing Tektronix 7854 surely deserves a bright spot in this story.

Program features at a glance:

- Acquire and transfer waveforms from the oscilloscope storage to the PC
- Display waveforms on the PC screen using standard and zoomed displays
- Save waveforms as .PNG images, .CSV files and .XLS spreadsheets
- Parse readout data and automatically set measurement units
- Different plugin type support: vertical + time base, X-Y, 7L5, 7L13 and 7L18 spectrum analyzers
- Upload of 7854 programs from the PC to the oscilloscope memory
- Issue custom commands to the oscilloscope

This document describes installation using the Agilent 82357B USB-GPIB adapter clone, but normally any VISA compatible GPIB adapter should work as well.

Contents

1 License

This program is free, but can be used for non-commercial and educational uses only. You may freely use and distribute this program in its original form with the included documentation (this document). There is no commercial version of this program, and no one may charge you for its download or usage.

The associated technologies this program is based on are registered trademarks of National Instruments and Agilent corporations.

The associated software components of this program are copyrighted by National Instruments and Agilent corporations, and subject to individual license agreements.

2 Requirements

2.1   Hardware requirements

1) A computer (laptop or PC) running Microsoft Windows operating system compatible with NI LabVIEW 2018. This program has been tested on Windows 7 SP1 and Windows 10. Depending on the available GPIB adapter, a free USB port or a PCI/PCI-e slot will be required.
2) IEEE-488 (GPIB) adapter or card with VISA compatibility. Currently this program has been tested using Agilent 82357B USB-GPIB adapter clone which can be purchased on eBay. Other VISA compatible adapters should work too.
3) Tektronix 7854 oscilloscope with GPIB port. This program has been tested with an instrument having Option 2D (increased memory), but should work normally with the standard instrument as well. 7854 keyboard is mandatory for uploading and running 7854 programs.

2.2   Software requirements

1) This program, which is available for free under the license conditions stated in the previous chapter.
2) National Instruments (NI) LabVIEW 2018 Run-Time Engine, a free download from the NI website. Please see the chapter on installation for more details.
3) GPIB adapter software installation, including VISA.

2.3   Notes on instrument calibration

To obtain satisfactory results, your 7854 and plugins should be well calibrated. This document contains a calibration program listing which can be uploaded to your 7854 to aid with the adjustments.

3 Installation

Currently this program has been tested on only one GPIB adapter: the Agilent 82357B USB-GPIB adapter clone which can be purchased on eBay. The rest of this manual will be based on this exact adapter, but the program should be usable with any VISA compatible GPIB adapter.

3.1   Oscilloscope port configuration

If the instrument is going to be alone on the GPIB bus, the following settings can be used:

3.2   Program download

The program is currently hosted on my web site at the following page:
http://www.nfilipovic.com/electronics/tektronix-7854

3.3   Notes on GPIB adapters and VISA

VISA API is a standalone component installed on a system level so it can be shared by multiple client programs, such as the one this document is all about. VISA installation is usually bundled with the GPIB adapter driver in a single installation package, or with development solutions such as the NI LabVIEW. VISA API can therefore originate from different vendors (e.g. Agilent, NI...), and multiple VISA installations can coexist on the same system under certain rules.

No matter how flexible, VISA platform on Windows is not perfect. At the time of this writing, interfacing the Agilent VISA from NI development environment such as LabVIEW was possible only using x86 (32 bit) libraries. For this reason, this program and its dependencies are all x86 (32 bit) builds.

3.4 Program architecture

The following diagram depicts the design and components necessary to run this program:
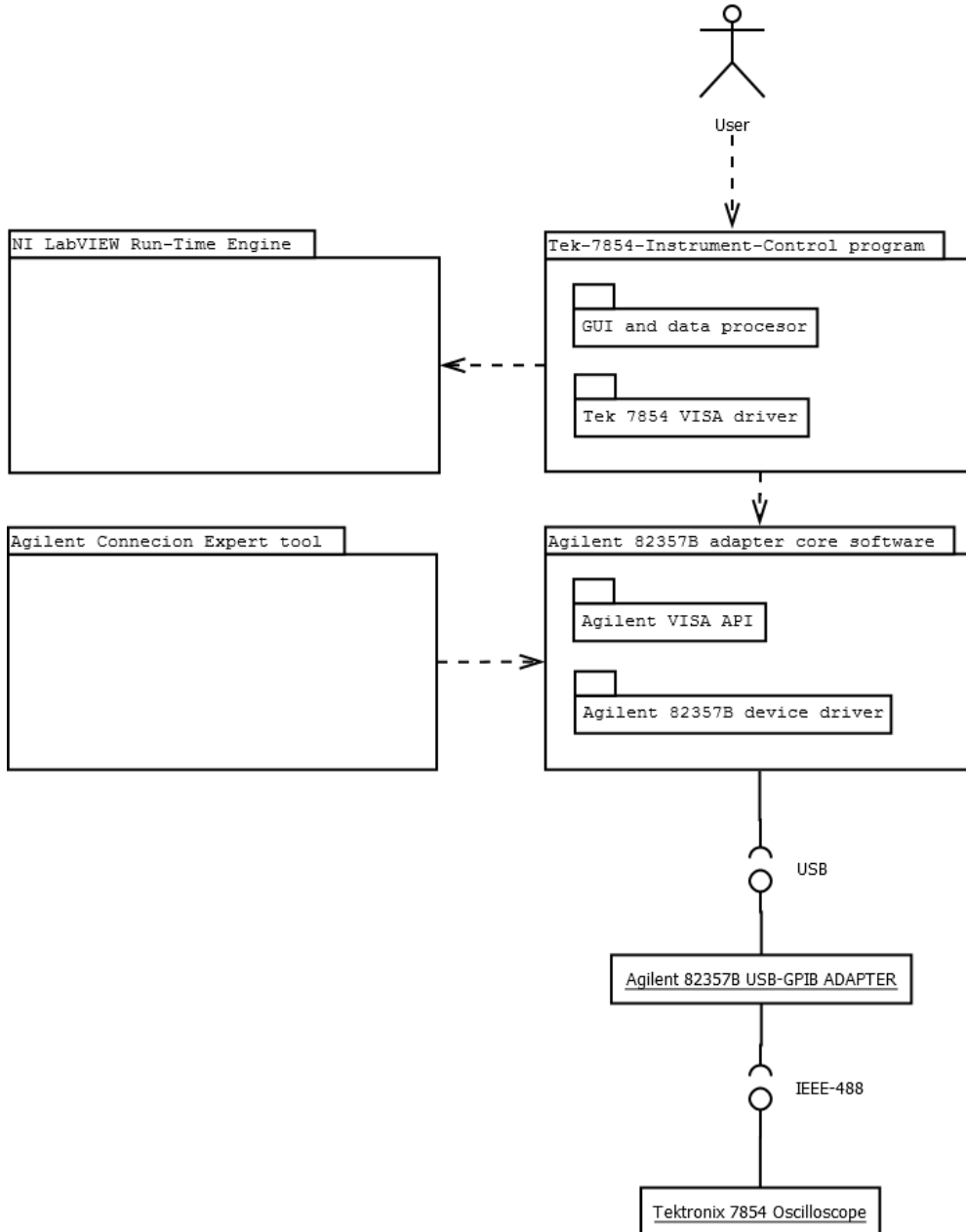
To summarize: besides the main program, the following components need to be installed separately (assuming Agilent 82357B USB-GPIB adapter is used):

- NI LabVIEW 2018 Run-Time Engine
- Agilent IO Libraries Suite (includes Agilent VISA and adapter device driver)

3.5   NI LabVIEW 2018 Run-Time Engine installation

This package should be downloaded directly from the National Instruments website at:

https://www.ni.com/en-rs/support/downloads/software-products/download.labview-runtime.html#359578

The site will require the user to register, which can be done free of charge. The choices on the download page should be set according to the following screenshot:

The download size is incorrectly reported in the above screenshot, the actual size is approximately 450MB. After downloading and unpacking the .zip archive, *setup.exe* should be started. The installation is fairly straightforward, but the following screenshots should help clear out any possible doubts:
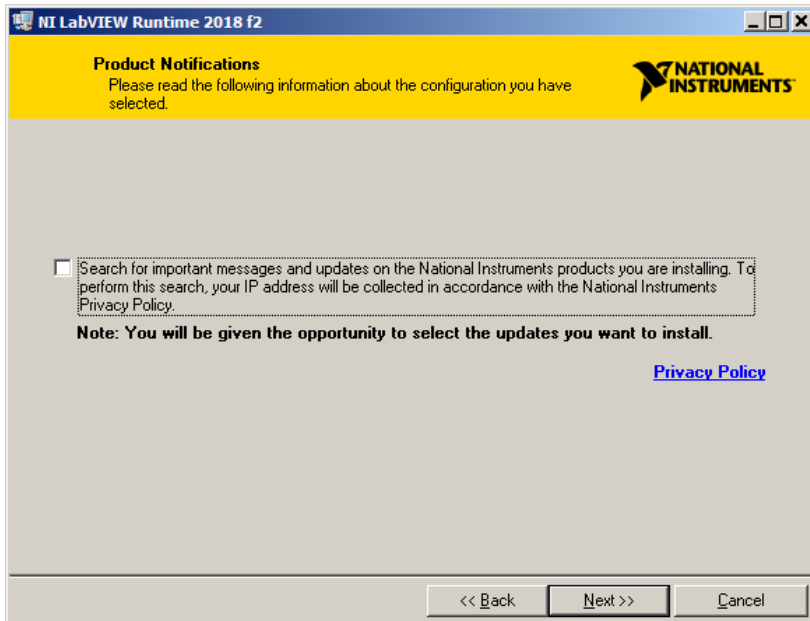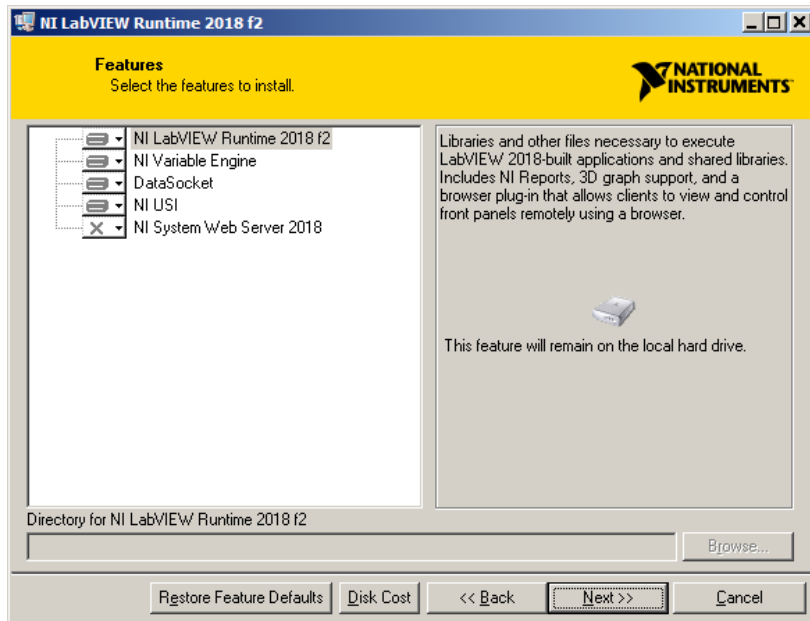
3.6   Agilent IO Libraries Suite installation

This software normally comes on a CD bundled with the adapter, but can also be downloaded separately. The installation is fairly straightforward:

If there are no existing VISA installations on the target system, Agilent VISA should be configured as the primary VISA. This setting is related to the shared VISA library deployed on the system, and actually has no effect on the Agilent software in this example:
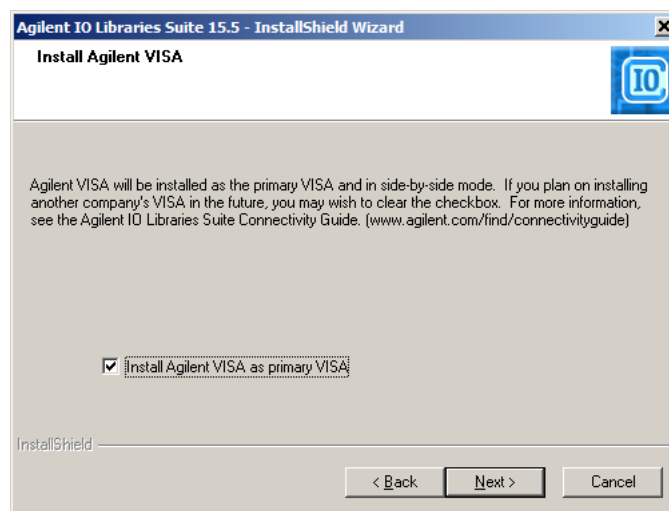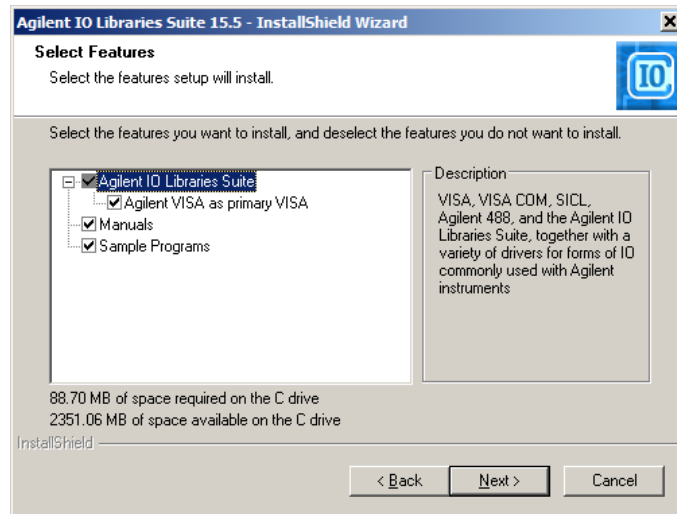
At the end of the installation, you will be notified of the system tray icon for the Agilent Connection Expert:

Once the driver is deployed by the above installation, Windows should report successful installation:

At this point you should plug the adapter into your 7854 oscilloscope, and power it up. Agilent Connection Expert should be used to check the connection:
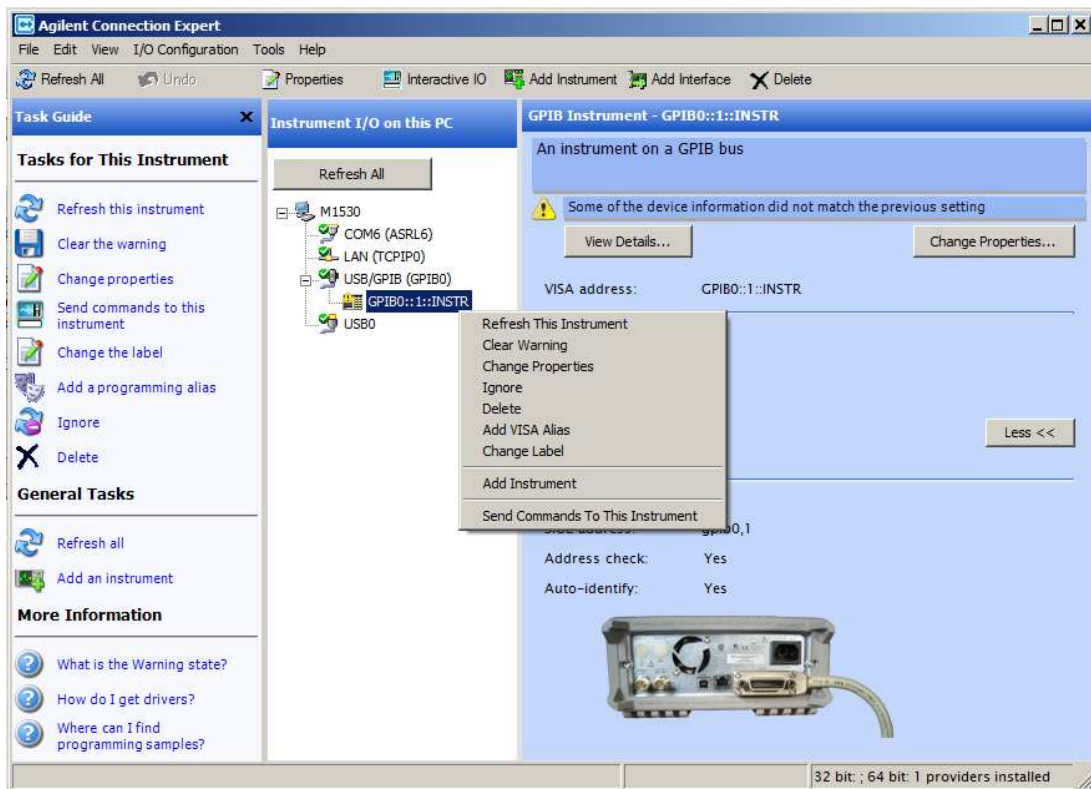
Normally an "unknown" instrument should appear under the USB/GPIB category (*GPIB0::1::INSTR* in the image above). 7854 does not understand the modern GPIB query commands for instrument identification, so the tool assigns such a cryptic default name. You can use the "Change Label" or "Add VISA Alias" to change the displayed name to something more descriptive (such as "Tektronix 7854" or similar).
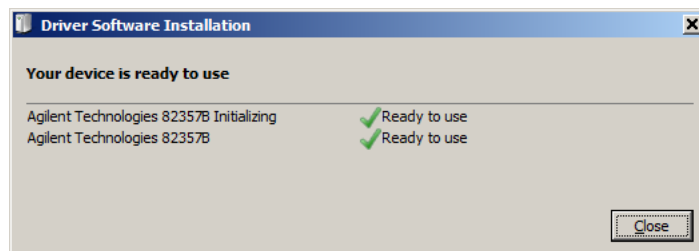
Starting Agilent Connection Expert may light up the "Error" LED on the 7854 front panel. This is normal and expected, for the same reason as explained above. The yellow exclamation mark in the Agilent Connection Expert window indicates the same, and should be ignored.

3.7   Alternative GPIB adapters

This program was tested with Agilent 82357B clone adapter only. VISA flexibility should warrant normal operation with any VISA compatible adapter. Please refer to the above chapters as principle reference for installing different adapters.

4 Appearance and controls

4.1   Screen resolution

By LabVIEW design default (single front-end VI), screen controls have fixed positions. It is recommended to run this program on displays with Full HD resolution (1920x1080) or larger, so that all controls can fit on the screen. Lower screen resolutions would cause the scroll bars to appear, so the view would have to be panned to access all controls.

4.2   Front panel design
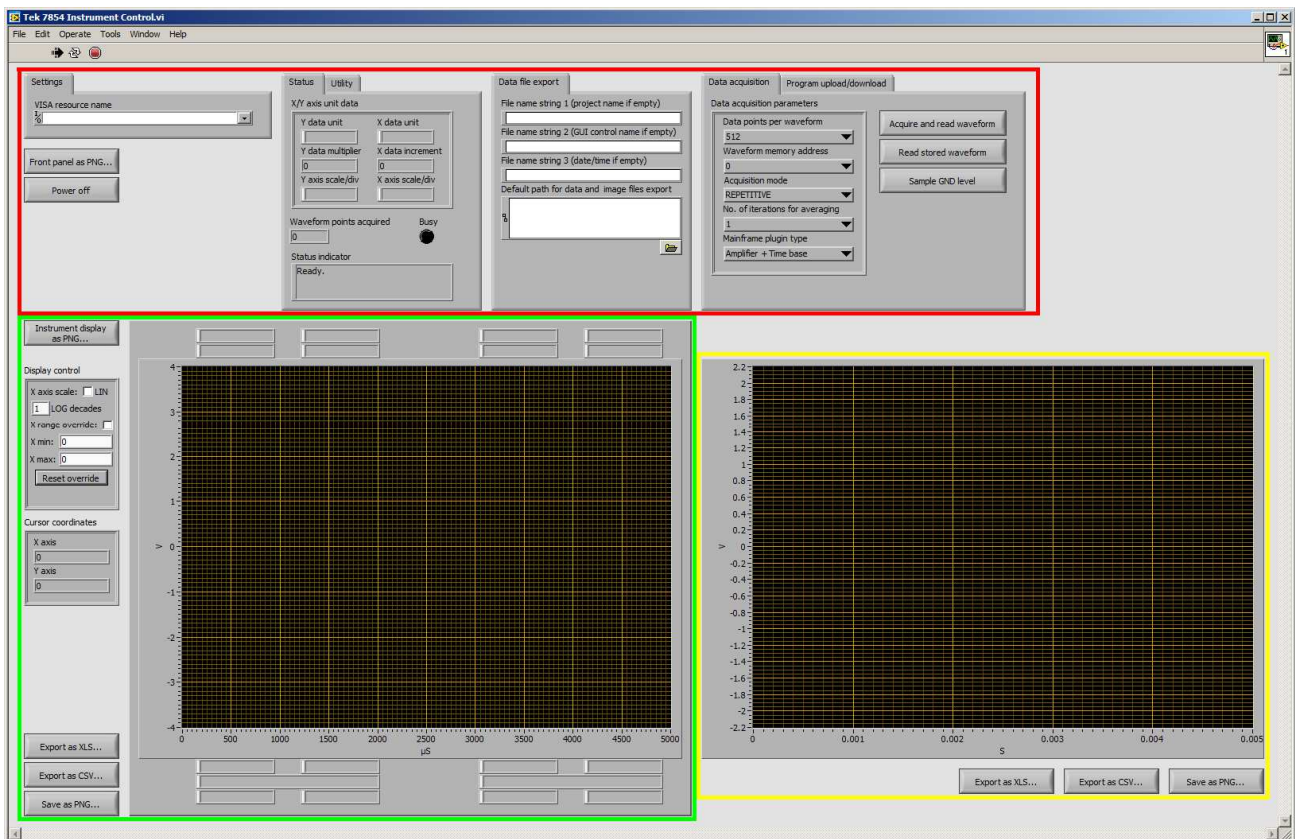
The front panel is roughly sectioned into three areas:

- Status and control section (red)
- Main instrument display (corresponds 1-to-1 with the CRT in storage mode) (green)
- Zoomed instrument display (automatically scales the Y axis to fit the measurement) (yellow)

4.2.1 Status and control section

Functional description of controls:

- **Settings:**
  - **VISA resource name:** Combo-box (drop-down list) should contain all VISA compatible devices on your system. The attached 7854 oscilloscope reference must be selected here - the same instrument detected using the GPIB adapter diagnostic tool (e.g. Agilent Connection Expert).
- **Front panel as PNG...:** Option to save the full front panel of the program as .PNG image.
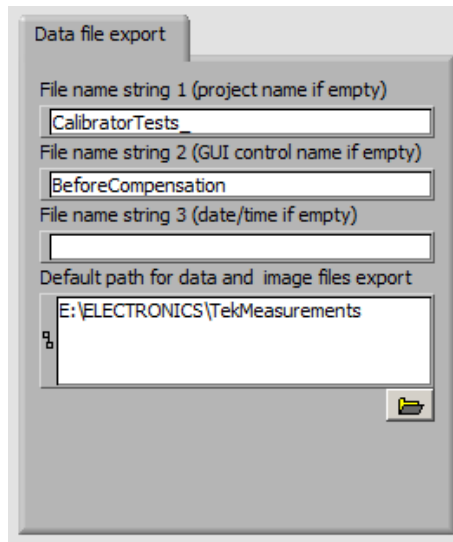- **Power off:** Shuts down the program.
- **Status:** Displays data acquisition status, namely the Busy state (waiting for the response from the instrument), the textual status of commands sent to the instrument...etc.
- **Utility:** Tools for sending commands to the 7854.
  - **Device clear (DCL):** Sends the DCL command to the 7854, to reset the CPU to the idle state. Useful if 7854 becomes stuck in a loop or encounters a critical error.
  - **Execute command:** Sends a custom command to the 7854. Please refer to 7854 documentation for the list of supported commands. The text box below the button and command entry displays the command response.
- **Data file export:** Instrument display content can be saved in various formats (.PNG, .CSV and .XLS). Data file export controls define a template for naming these files, in form of three concatenated strings. For example, saving a .PNG image with the following settings:


The above settings would produce the following full file path:
E:\ELECTRONICS\TekMeasurements\CalibratorTests_BeforeCompensation_20210813_16-28-43.png
If any of the fields are left blank, the program will use the internal default value prefixed by the underscore character.

- **Data acquisition:** The heart of the program functionality.
  - o **Acquire and read waveform:** Digitize and transfer the waveform from the oscilloscope to the PC. Parameters from the **Data acquisition parameters** group apply to this command.
  - o **Read stored waveform:** Transfer the previously digitized waveform from the oscilloscope to the PC. Parameters from the **Data acquisition parameters** group should match the settings used to acquire the waveform (notably the number of data points and the waveform address).
  - o **Sample GND level:** Executes the GND command that sets the ground reference level for digital storage. This will establish a proper offset to Y axis data in the displayed waveform.
  - o **Data acquisition parameters:**
    - ▪ **Data points per waveform:** Sets the number of data points for the acquisition, or used to match the data points while reading a manually acquired waveform.
    - ▪ **Waveform memory address:** Sets the index in the oscilloscope memory where the acquired waveform will be stored, or selects the index of the waveform to read.
    - ▪ **Acquisition mode:** Selects one of the three available acquisition modes of the 7854 oscilloscope (AQS, AQR and AVG commands). Please refer to the 7854 documentation for details.
    - ▪ **No. of iterations for averaging:** Applies only to the AVERAGING (AVG command) acquisition mode.
    - ▪ **Mainframe plugin type:** Affects the data processing of the transferred waveform, and should be set according to the horizontal and vertical plugins selected on the oscilloscope. This mainly applies to the readout data which needs to be displayed correctly, and automatic recognition of measurement units.
- **Program upload/download:** Tools to manage the proprietary programs the 7854 CPU can execute. **Note:** at the time of this writing the program download has not been implemented yet.
  - o **Program upload:** Upload the 7854 program from a file to the oscilloscope memory. The oscilloscope keyboard should be used to run or pause the program execution.

4.2.2 Main instrument display
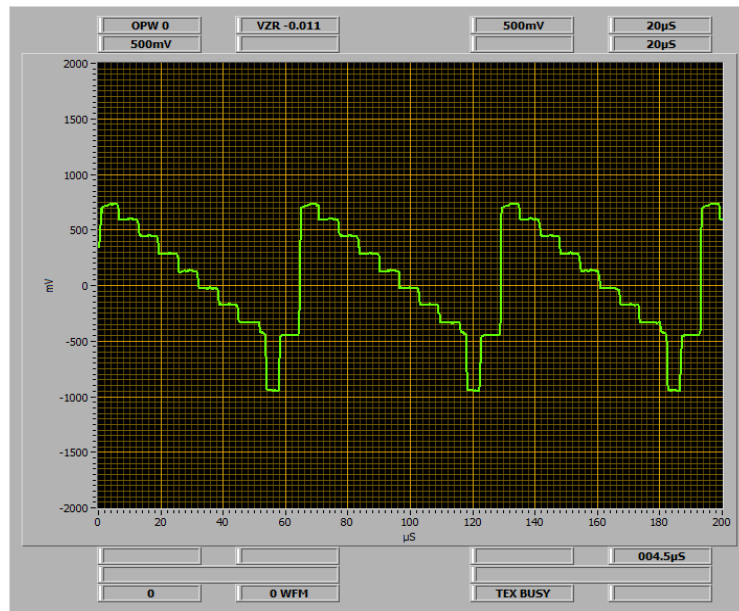
This display corresponds 1-to-1 with the CRT in storage mode, while readout fields use dedicated text boxes. As on the physical instrument, readout is grouped into top and bottom fields. The first row of top readout fields corresponds to STORED mode readout, while the second row is the SCOPE mode readout. This order is mirrored at the bottom readout: the first row is for SCOPE mode, while the second is for STORED mode. Axis units are set automatically (assuming the correct setting of **Mainframe plugin type**).

- **Instrument display as PNG:** Saves the display together with readout fields as a .PNG image.
- **Display control:** Can change the display of the transferred waveform.
  - **X axis scale:** Can select from the LIN or LOG scale. This setting only configures the display, the waveform data remains unchanged.
  - **LOG decades:** Determines the number of decades for the logarithmic display. Due to the limited number of total data points the 7854 can produce, it won't make sense to use a number greater than 2 here. Otherwise the beginning of the waveform will be severely under-sampled.
  - **X range override:** Useful for plugins with inaccurate readout of the X axis data, such as the 7L13/7L14 spectrum analyzers. If you have the means to obtain the correct range for the X axis, enable the override and use the two text boxes to set the proper range.
- **Cursor coordinates:** Displays the numerical coordinates (in the proper unit scale) of the mouse pointer while hovering over the main instrument display.
- **Export as XLS:** Exports the waveform data in Microsoft Excel format.
- **Export as CSV:** Exports the waveform data in plain text CSV format.
- **Save as PNG:** Saves only the instrument display (excluding readout fields) as a .PNG image.

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4.2.3   Zoomed instrument display
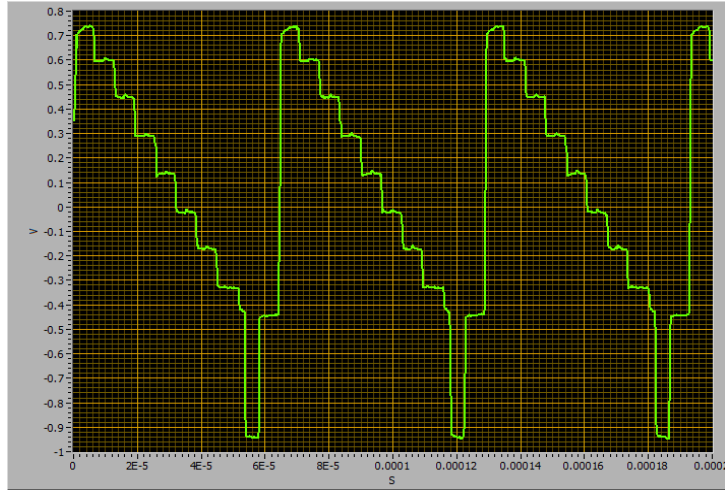
This display automatically zooms in the waveform depending on the Y axis data range. This is helpful if the oscilloscope and acquisition controls need to be kept at settings that result in a low absolute amplitude of the observed waveform.

- **Export as XLS:** Exports the waveform data in Microsoft Excel format.
- **Export as CSV:** Exports the waveform data in plain text CSV format.
- **Save as PNG:** Saves the zoomed instrument display as a .PNG image.

4.3   Numeric data export

The CSV and Microsoft Excel exports can be used for subsequent data processing. These exports contain two columns of X and Y data, therefore each row being one data point. The Excel spreadsheet contains a graph to help designate the measurement, example:
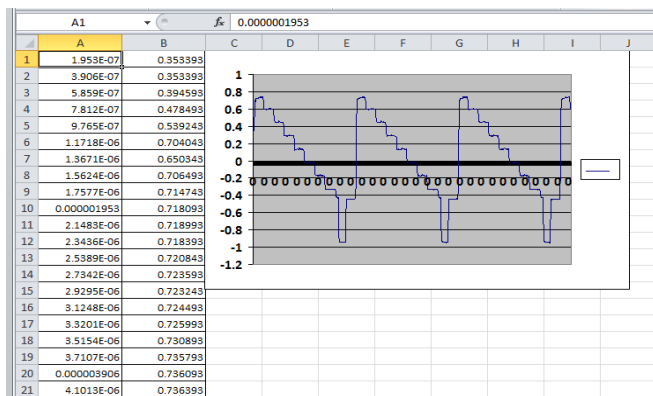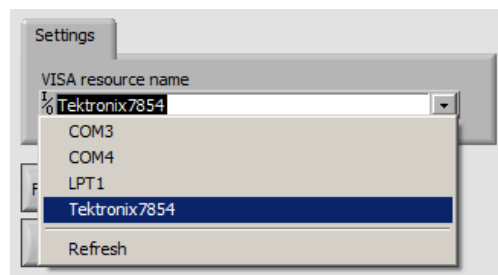
5 Taking measurements

This section assumes you operate the 7854 oscilloscope front panel at the same time with the program on the PC.

5.1 Choosing the VISA instrument

The first thing to do after starting the program is to choose the **VISA resource name** corresponding to your 7854 oscilloscope. Note that in your particular case the name may be different, depending on whether you used the connection diagnostic tool to rename the instrument (VISA label or alias).

If the instrument does not show up immediately, click the Refresh option in the drop-down list. Additional information on this can be found in the Installation chapter.

5.2 Configuring data acquisition and taking measurements

If your 7854 is equipped with standard amplifier + time base plugins and you have them selected, the program can be used with the default settings. After obtaining stable triggering, you can use **Acquire and read waveform** right away. If you prefer to fine tune the acquisition on the oscilloscope itself until you obtain a satisfactory waveform in storage, you should use the **Read stored waveform** button. In the latter case, be sure to set the same waveform parameters under **Data acquisition parameters** that you have set on the oscilloscope.

5.2.1 Amplifier + Time base

7854's CPU alone cannot tell what your current ground level is (the Position knob on the vertical amplifier, a fully "analog" control). The ground reference is required so that Y axis values can be properly offset in digital data. Digital storage assumes the center horizontal graticule line as the default ground level, and this is reported by the oscilloscope as VZR 0 in the STORED readout data.

To make a measurement with an arbitrary ground level, do the following:

- Switch the currently selected vertical amplifier input to GND, and set the desired ground level using the Position knob.
- Click the **Sample GND level** button. The operation should complete quickly.
- Switch the currently selected vertical amplifier input to DC or AC.
- Use **Acquire and read waveform** to obtain a waveform. Y axis should be properly offset depending on the sampled level. The same can be accomplished by storing the waveform using oscilloscope commands, and using the **Read stored waveform**.

The oscilloscope will report the current ground level through the VZR readout field ("Visual Zero Reference"). VZR is normalized to major horizontal graticule lines; the distance between any adjacent lines changes the VZR by 1. The central line defines the VZR of 0. The following example shows the 4V calibrator signal being recorded with the ground level roughly set at two graticule lines below the central one:
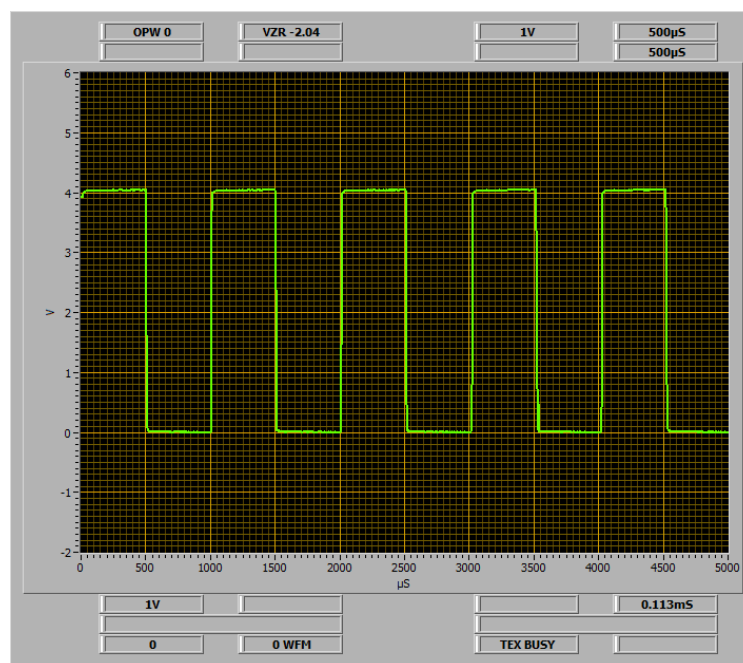
Obviously the VZR is a decimal number, and the oscilloscope can return up to 3 digits past the decimal point. Such high precision would result in awkward values of the major graticule lines on the Y axis, so the program rounds the VZR to one digit past the decimal point. The following example uses a ground level roughly 2.3 graticule lines below the central one:
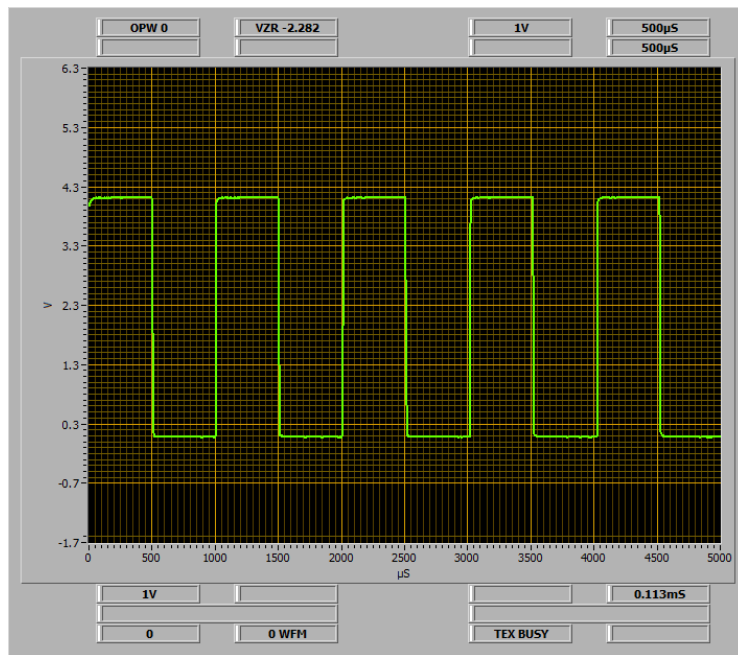
The exact (sampled and stored) VZR is reported in the STORED readout, and the rounded value is used for the Y axis and the displayed waveform.

5.2.2 Amplifier + Amplifier (X-Y)

This mode is fairly limited by the 7854 storage design, but can still be useful if the following is observed:

- The X axis zero value is at the center vertical graticule line. You can use the **X range override** to set a custom range.
- The following restrictions must be observed:
  - The horizontal amplifier needs to scan the full X range (like the time base does), so the digitizer can sample all points.
  - Sampling the Y ground level is possible, but with the previous restriction.
  - The resulting waveform must not be a loop – each X point must have not more than one corresponding Y point.

5.2.3 7L5 spectrum analyzer

7L5 requires a modification to make it compatible with 7854 storage acquisition. More details on this modification can be found on the TekScopes mailing group and member websites:

https://groups.io/g/TekScopes/message/150089
http://www.hakanh.com/dl/docs/custommods/7L5modFB.pdf

7L5's own digital storage must be turned off in order for 7854 acquisition to work. It is recommended to use plenty of averaging and the highest resolution (1024 data points). Spectrum analyzer sweeps tend to be slow; to avoid VISA timeouts in the program it is recommended to use **Read stored waveform** after performing the acquisition manually on the oscilloscope.
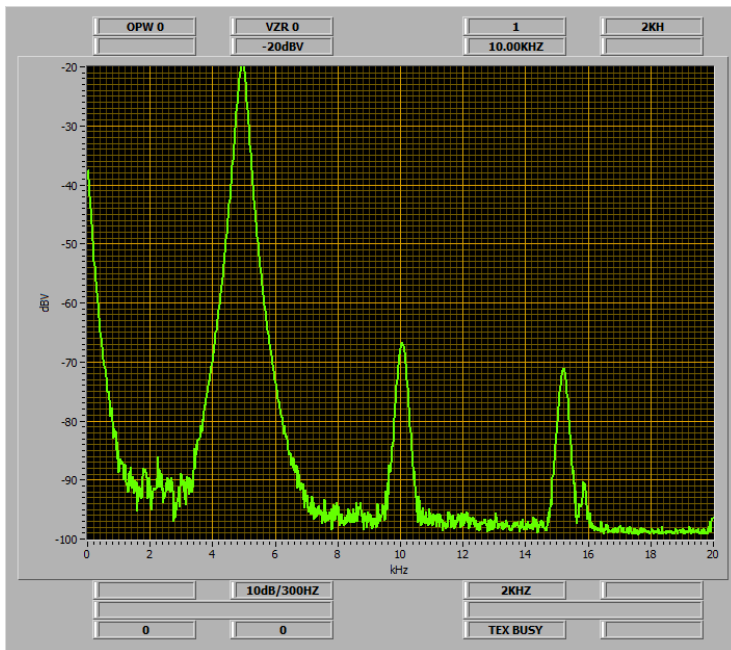
The above screenshot depicts the default LOG 10dB/div mode. LIN mode is also supported, which can be convenient for noise and other absolute measurements:
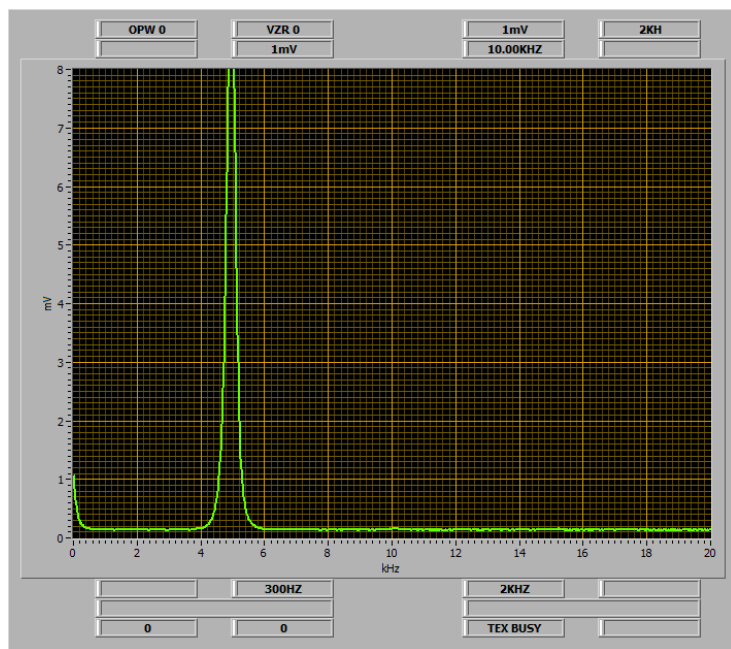
5.2.4 7L13 spectrum analyzer

This mode applies to the 7L14 as well, assuming its own digital storage is turned off. The program can recognize the full span mode (example taken from a P6201 probe calibration):
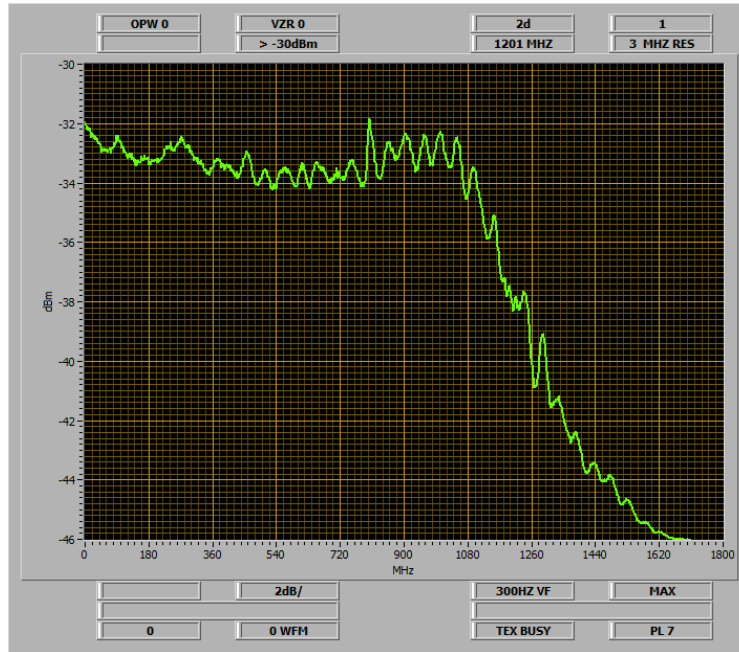
When using more narrow spans, the poor precision of the 7L13 center frequency readout will become noticeable. This can be seen in the next example (taken from a vintage PAL BW television receiver IF calibration):
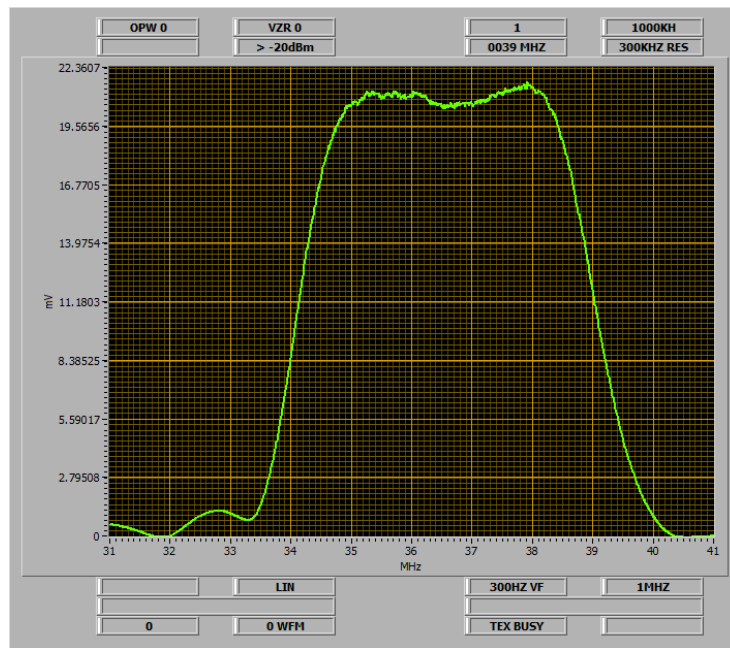
The wrong center frequency readout of 39MHz has been overridden using **X range override** to the proper range. The practical means to obtain the correct center frequency or range may be the TR502/DC508 combo, or using a known reference signal insertion.

5.2.5   7L18 spectrum analyzer

I have not performed many measurements using this instrument, but almost all of the guidelines for 7L13 also apply here.

6 7854 programs

7854 has the unique feature to execute sequential programs where instructions and oscilloscope commands are mixed together. This can be used to automate measurements, as well as perform quick operation on the data.

With the aid of this PC program, 7854 programs can now be saved and loaded to the oscilloscope quickly and easily. This creates a whole new dimension to this unique feature of the 7854, which has lingered in minimal use for decades.

6.1   File syntax and indentation rules

7854 is incredibly smart for its age, but care must be taken that it understands the data sent to it. The following rules define the format of the program files:

- ANSI format with Windows CR/LF line ending.
- Only single line comments starting with "//" are supported.
- Empty lines are allowed, and will be skipped by the parser.
- All commands and data need to be separated using single whitespace characters.
- Literal characters (integer digits, decimal point) need to be separated by a single whitespace character.
- All digits of multi-digit integers need to be separated by a single whitespace character.

The easiest way to get a hold of these rules is to examine the sample programs that follow in the next subchapters.

6.2   Uploading and running programs

The oscilloscope needs to be in the PROGRAM ENTRY mode prior to upload (available on the 7854 external keyboard). Select the program file using **Program file path** and click the **Program upload** button. The upload progress can be monitored on the oscilloscope CRT in real time.

The uploaded program needs to be started manually. Depending on the particular program implementation, RUN and STOP commands may be used in sequence to repeat the sub-routine execution.

6.3   7854 program examples

6.3.1   Apply flat correction waveform in dB

By far the most frequently used program, mainly for the 7L13 spectrum analyzer. The system response when using a tracking generator or a noise source is never perfectly flat, example:
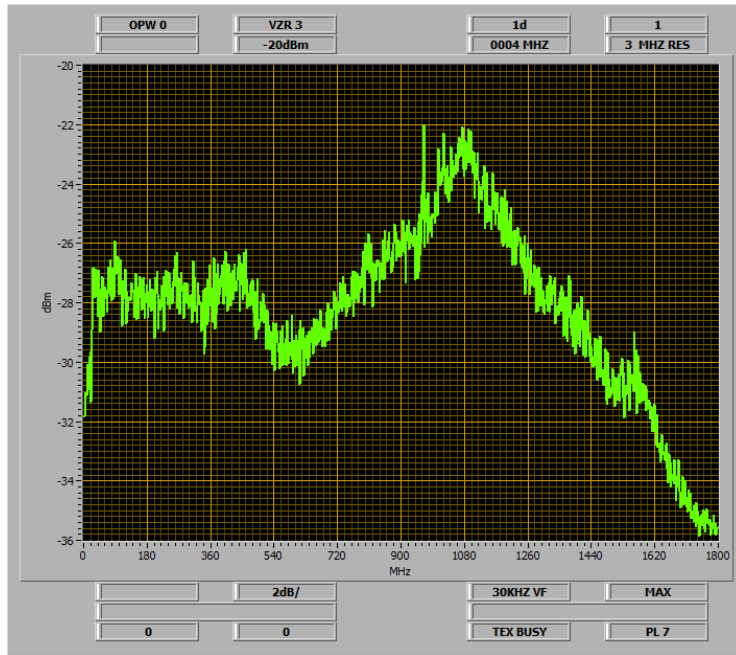
The above response is from a cheap white noise source. This reference was sampled by invoking START after the program upload. Invoking RUN subsequently takes a new measurement and applies the correction:
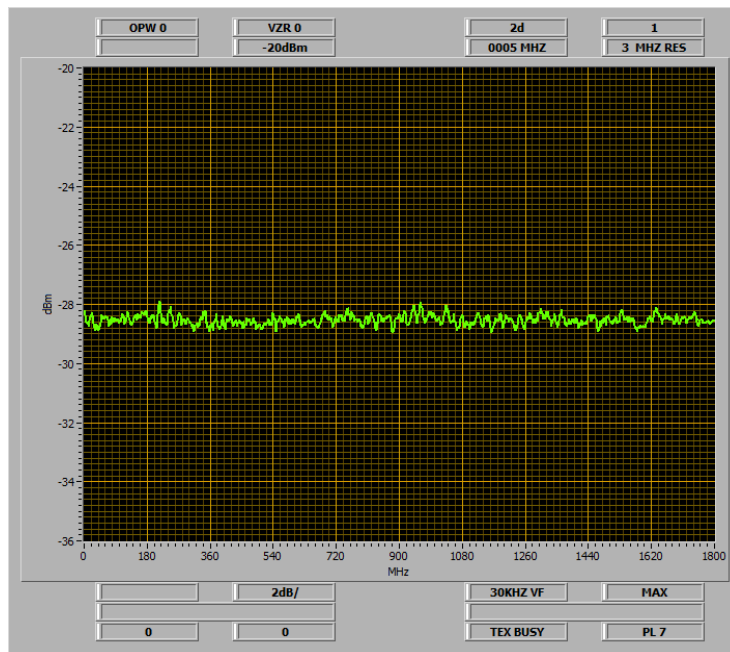
The correction waveform remains in memory; each invocation of RUN takes a new measurement and applies the correction. Program listing:

```
// Application of a flat waveform correction (stores a "flat" waveform that
// represents a reference response of the measurement system (e.g. amplitude
// response), then applies this waveform (plain subtract as the unit is dB) to
// correct the subsequent measurements.
// – best used for spectrum analyzer sweeps
// – invoking START acquires the reference (flat) waveform and caches it WFM 2
// – subsequent invocation of RUN acquires the waveform and applies correction
// – corrected waveform is referenced to its highest peak

1 0 2 4 >P/W
STORED OFF CLS
LNN 0 1 1 0 AVG
// Position the cursor at 1/2 first graticule division to skip the 0Hz spur
CRS1 HSCL 2 / >HCRD
// Reference the highest peak of the response
0 WFM MAX – OFF 2 >WFM
LNN 0 2
STOP
// Preserve VSCL and VZR
1 0 AVG VSCL 2 >CNS
0 WFM 2 WFM – . 0 5 SMOOTH
0 >VZR VSCL 2 CNS / VXPD
2 LBL GOTO
```

6.3.2 Amplitude comparison in dB

This is best applied to periodic real-time signals where at least 10 or more periods fit the CRT screen. Instructions for saving the reference and taking measurements can be found in the program listing:

```
// Amplitude comparison in dB
// - invoking START acquires the reference waveform and caches it WFM 2
// - subsequent invocation of RUN acquires the waveform to compare
// - to re-acquire the reference on each run, change the last GOTO label to 1

1 0 2 4 >P/W
STORED OFF CLS
LNN 0 1
1 0 AVG . 0 5 SMOOTH 2 >WFM
LNN 0 2
STOP 1 0 AVG . 0 5 SMOOTH
2 WFM P-P 0 WFM
X<>Y P-P X<>Y /
LN 1 0 LN / 2 0 *
2 LBL GOTO
```

6.3.3 Logarithmic X axis display

Spectrum analyzer sweeps are often more useful with the logarithmic X display. This program uses a 7854 feature (the "VS" display) where the data can be displayed versus an arbitrary function, as opposed to the default linear function. The benefit is speed (no data conversion), but the drawback is that the logarithmic view cannot be transferred over GPIB. Program listing:

```
// Changes the X axis display from linear to logarithmic
// - practical limitation: 2 decades span
// Stores the logarithmic transfer function in WFM 2 (can be re-used)
// - transfer function needs to be expanded to 10 division vertically to
//   provide full deflection in the VS mode
// - to revert to conventional display (time abscissa) invoke TIME command
// - to activate logarithmic display again, invoke 2 VS command

1 0 2 4 >P/W
OFF 0 WFM ENTER - 1 +
INTG MAX 1 0 0 / +
LN MID - 1 0 P-P VSCL / / VXPD
2 >WFM

// Acquire waveform (as noise free as possible)
// - use as much averaging as conditions permit
// - fine smoothing also recommended
1 0 AVG . 0 5 SMOOTH
// AQR . 0 5 SMOOTH
```

6.3.4 Logarithmic X axis conversion

This program performs the real data conversion at the expense of speed. Since the logarithmic display is available in the PC program, it is hardly useful and presented here just for demonstration. Program listing:

```
// Converts acquired waveform in WFM 0 to 2 decades span logarithmic X axis
// - creates an exponential transfer function in WFM 2 (can be re-used)
// - saves a copy of acquired original in WFM 3

// Preset highest resolution
1 0 2 4 >P/W STORED

// Create exponential transfer function in WFM 2 (can be re-used)
// - Solution 1: Very slow but accurate for 2 decades span
// - f(x) = a*(exp(b*x) -1), a=12.7875, b=0.00429565; x in [0,1023]
// - running time: 4m35s (275sec) using either multiplication or division
// OFF 2 WFM 4 CHS >VZR 2 0 0 >VSCL
// 0 ENTER 0 >CNS
// 1 2 . 7 9 ENTER 1 >CNS
// 2 3 2 . 8 ENTER 2 >CNS
// LNN 0 1 0 CNS 2 CNS / EXP
// // 4 2 9 5 EEX 6 CHS ENTER 2 >CNS
// // LNN 0 1 0 CNS 2 CNS * EXP
// 1 - 1 CNS * 0 CNS >PNT
// 1 0 2 4 ENTER 0 CNS 1 + 0 >CNS
// IFY>X 1 LBL GOTO
// STOP

// Solution 2: Much faster but only an approximation tuned for 2 decades span
// - tuning target: logarithmic X axis midpoint: f(511) = 102.3
// - constant 0.438 produced f(511) = 102.9 which is close enough
OFF 0 WFM ENTER - 1 >VSCL >HSCL
0 WFM 0 . 4 3 8 +
INTG EXP 1 - P-P 1 0 2 3 / /
2 >WFM
STOP

// Acquire waveform (as noise free as possible) and save a copy in WFM 3
// - use as much averaging as conditions permit
// - fine smoothing also recommended
1 0 AVG . 0 5 SMOOTH 3 >WFM
// AQR . 0 5 SMOOTH 3 >WFM

// Perform conversion directly on WFM 0
// - possible due to the fact that f(x) is always less or equal than x
// - running time: 4m22s
1 0 2 3 ENTER 0 >CNS
LNN 0 2 2 WFM 0 CNS PNT
0 WFM X<>Y PNT 0 CNS >PNT
0 CNS 1 - 0 >CNS 0 ENTER
IFY>X 2 LBL GOTO
```

6.3.5 Calibration test pattern generator

This program draws a rectangular pattern on the CRT screen which is required to complete the 7854 calibration. Program listing:

```
// Generates a rectangular test pattern required for calibration procedure
// - Service Manual Calibration Part II: GB. DISPLAY SYSTEM, pages 4-83 to 4-86
// - Upon start generates a rectangular pattern and stops
// - Subsequent continue (pressing RUN) alternates between dot and vector modes

1 0 2 4 >P/W TIME DOTS OFF 0 WFM 0 *
P/W 1 0 / >HSCL P/W 6 / 0 >CNS CLS
1 >CNS 3 CHS ENTER 3 ENTER
1 0 LBL GSB
3 ENTER 3 CHS ENTER 1 0 LBL GSB
3 CHS ENTER 3 ENTER 1 0 LBL GSB
3 ENTER ENTER 1 0 LBL GSB
0 ENTER ENTER 1 0 LBL GSB
3 CHS ENTER ENTER 1 0 LBL GSB
VSCL VXPD 0 WFM 1 >WFM
1 . 3 3 3 3 3 3 CHS VXPD HSCL 5 * HPRGT
0 WFM 1 VS STOP
LNN 0 5 DOTS PAUSE VECT PAUSE
5 LBL GOTO
LNN 1 0 2 >CNS CLX 1 CNS >ORD
1 CNS 0 CNS + 1 >CNS
1 - 2 CNS X<>Y >ORD
ITRP RTN
```

7 References

1) The TekScopes mailing group, this is where the most of the vintage Tektronix wizards dwell: https://groups.io/g/TekScopes
2) National Instruments LabVIEW: https://www.ni.com/en-rs/shop/labview.html